Ohio Agricultural Experiment Station

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SOME IMPORTANT INSECT PESTS OF THE GREENHOUSE

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WHITE FLY, ALEYRODES, MEALY WING, SNOWY FLY

Aleyrodes vaporarium

These insects form the link between the aphids and scale insects. They agree with the former in that the adults are winged, and with the latter in that the larvae hatch from eggs laid on the undersides of the leaves and after settling down they resemble very closely minute scales, similar to young mealy bugs, except that they are without spines on the outer margin. The eggs are very small (about 1-100 of an inch long), slightly oblong, and somewhat pointed at one end, the rounded end being attached to the under surface of

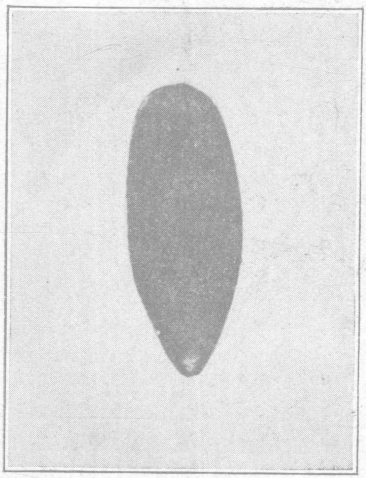
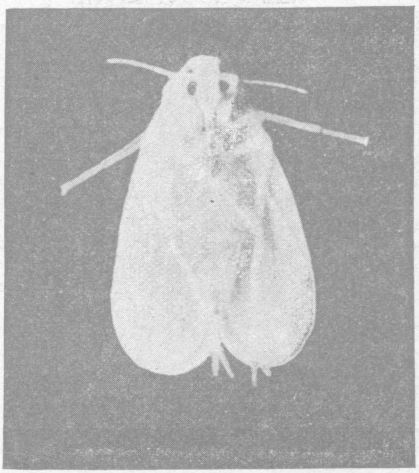


Fig. 1. Egg of white-fly, greatly enlarged (after Britton).



Adult female, ventral view, greatly enlarged (after Britton).

the leaf. At first they are of a greenish-yellow color, but they become dark brown just before hatching. The eggs hatch in about two weeks and the young nymphs crawl around for a short time, then insert their beaks in the succulent tissues of the leaf, remaining in this position, and, to a casual observer, they would be mistaken for small scale insects. In about 3 or 4 weeks the adults appear. The adults, both male and female, are white, yellow-bodied, winged insects, measuring about 1-20 of an inch in length. The eggs laid by unfertilized females will hatch, but so far as known, produce nothing but insects of the male sex. The adults, as a rule, live several weeks, and the female usually lays several dozen eggs before she dies; a not uncommon number being from two to three dozen, although Morrill gives a record in Massachusetts Agricultural Experiment Station, Bul. 1, of more than 129 eggs laid by one female in 36 days. She frequently lays her eggs in small circles of from 5 to 10 eggs. This act is performed by inserting her beak in the tissue of the leaf, and with this point as a center, she describes a circle with her ovipositor.

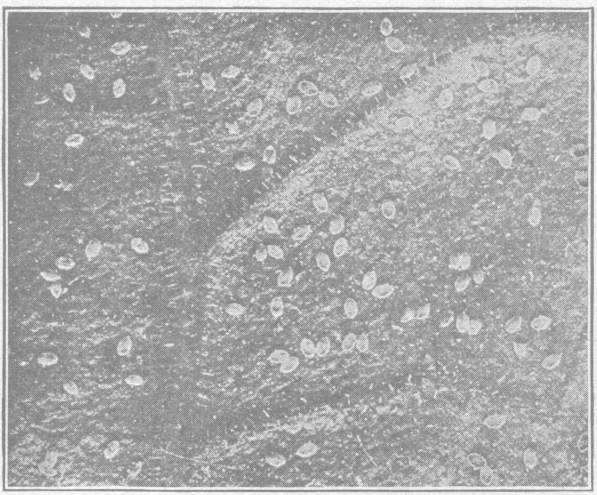


Fig. 2. Nymphs. Enlarged about four times (after Britton).

The natural family to which this insect belongs is tropical, and the species is supposed to have been introduced from Brazil or Mexico into greenhouses in Europe and North America. Because of the nature of the insect, it is unable to survive our winters out-of-doors, unless in the shelter of some heated building like a greenhouse. However, it is today rated as one of our worst greenhouse pests, is widely distributed, and has a host of food plants. A few,

such as the following, are of special economic importance: Cucumber, lettuce, tomato, egg-plant, rose, coleus, chrysanthemum, geranium, etc.

It injures the plants by sucking the juices from the under surfaces of the leaves, both while in the nymph and adult stage. These leaves, if the attacks are severe, soon become exhausted, dry up and die. The insect deposits a sticky substance on the under surface of

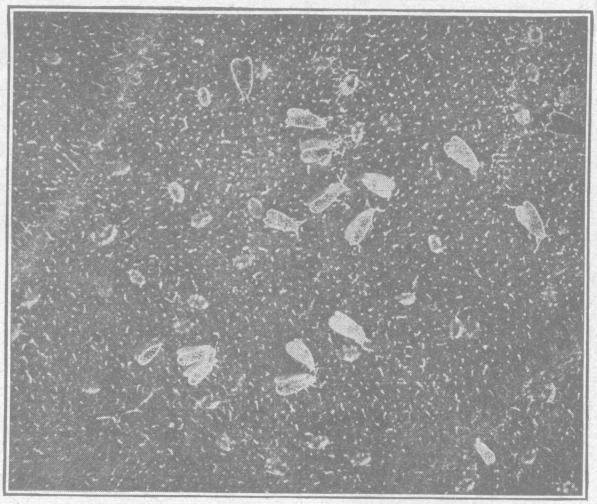


Fig. 3. Adults and pupa skins. Enlarged about four times (after Britton).

the leaves, which tends to close the stomata and supports a black fungus, which is not infrequently observed. This sometimes is found on the upper surface, but never to the same extent as on the underside. Most of the damage is done during the nymph stage. The adults, as a rule, prefer to deposit their eggs on the young, tender shoots and, as a consequence, the lower leaves are the first to be destroyed. The adults may become so abundant that they arise in clouds when the vines are disturbed. During the summer they migrate to crops out-of-doors, but in the fall, when the crops for winter are started, they soon find their way into greenhouses.

Remedies: Tobacco is not a satisfactory material to use in fumigating for white fly. Sprays of all kinds are rather unsatisfactory, because it is difficult to reach all the places where the insects are concealed, such as on the under-sides of leaves, often curled. At best, spraying is never entirely satisfactory in that it is next to impossible to reach all portions of the plant with the spray and when a small number of the insects escape, they form a start

for new infestation. Potassium cyanide is by far the most important material to use in the fumigation of greenhouses for white fly. One must be very careful, however, in the use of cyanide of potassium, as too much will injure the foliage. A great deal regarding the quantities to be used depends upon the construction of the greenhouse. Poorly constructed greenhouses may require twice as much material, or even more, than the well made, up-to-date house. In general, one might say that the amount of cyanide varies from 1-5 to 1-6 of an ounce to 1000 cu. ft. of space for 3 hours after dark, to 1 ounce to 1000 cu ft. lasting over night. Fumigation will have to be repeated in two weeks. Another thing to bear in mind is the age of the plants. An older plant will stand a stronger dosage than a younger, more succulent plant. It is also well to have the temperature as low as 55°, if possible, for best results.

GREENHOUSE MITE, RED SPIDER
Tetranychus telarius

This pest was first described by Linn. in 1761, and was recognized as a pest in greenhouses as early as 1877. It is known the world over and feeds on a great variety of food-plants. The number of eggs laid by a single insect is variable, a great deal depending on the nutrition and temperature. Under ordinary conditions, one might say that the number of eggs deposited varies between 10 and 50. The laying of eggs may be entirely suppressed, should there exist a low temperature and lack of sufficient food. The eggs, which are spherical, and a little less than 1-250 of an inch in diameter, are white in color when first laid and become reddish as the time of hatching approaches. They are usually laid close together and the time of hatching varies from 3 or 4 days to a week. Both fertilized and unfertilized eggs will hatch, but in the case of the unfertilized the insects are all males, while the fertilized produce both sexes.

The young crawler, when it first emerges from the egg, has only three pairs of legs, measures about 1-125 of an inch long, and is of a pinkish-white color with red eyes. This stage usually lasts about 3 to 4 days. On molting the first time, the insect emerges with four pairs of legs instead of three, and measures about 1-100 of an inch in length. This stage lasts about the same length of time as the first stage. In the third and last stage before they become adults, they acquire the habit of spinning webs, and can only be distinguished from the adults by the lack of red color which is so common in the adult, and by the characters which distinguish the sexes. They measure approximately 1-75 of an inch in length, and the period before changing to the adult stage is about the same as in the previous stages.

This mite, on changing to the adult stage, is variable in color, the most common colors being red or orange, green and yellow. The two latter colors undoubtedly result from the food which they eat, whether it be the green chlorophyll, or a closely related yellow pigment called etiolin. The life of the adult varies somewhat, being chiefly influenced by temperature. Under ordinary conditions, 3 to 4 weeks is about the period.

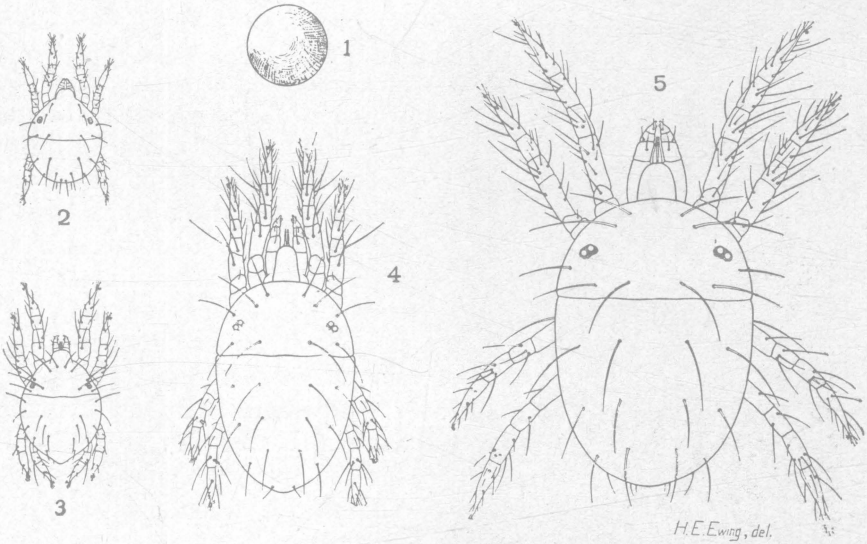


Fig. 4. All stages of the greenhouse mite drawn to same magnification. 1, Egg. 2, Larva. 3, Protonymph. 4, Deutonymph. 5, Adult female (after Ewing).

Food Plants: Among their most favored host plants found in greenhouses, may be mentioned a few of those of economic importance, such as rose, violet, carnation, chrysanthemum, tomato, cucumber and egg-plant. They show preference for the tender portions of the plants; parts that become old and hardened are less sus-

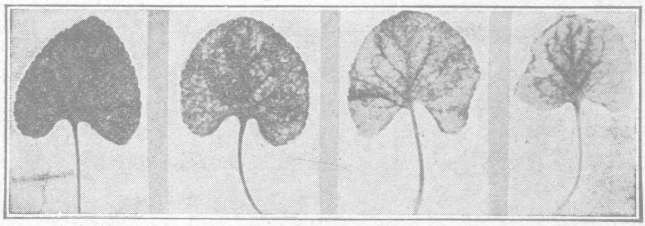


Fig. 5. Series of violet leaves, showing progressive stages of injury (from left to right) due to our common greenhouse mite (after Ewing).

ceptible to attack. Also hard-tissued plants, such as the palms, are not attacked, as the mites are unable to penetrate the tissues. Such plants as the radish, beet, onion, cabbage and turnip have been found quite resistant to the attacks of these mites.

Character of Injury: Ordinarily, the mites prefer to work from the underside of the leaf, but we have an exception in the carnation, in that they prefer to work from the upperside. These mites injure their host plants by inserting their beaks and sucking the juices, thus leaving a small white or yellowish spot, which is due to the extraction of the chlorophyll. The white or yellowish speckling of leaves and the fine webs made by the mites are strikingly characteristic of their work. If their attacks continue unchecked it is but a short time until the leaf loses its function, drys up and dies.

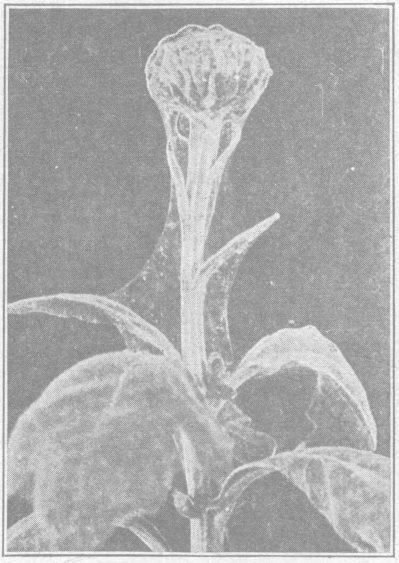


Fig. 6. Badly infested chrysanthemum bud showing web made by mites (after Ewing).

Remedies: Prevention is by far the best policy to follow in the control of greenhouse mites. This can be accomplished by the free use of water as a spray, and by the wetting of walks, etc., so that the house does not become too dry, for a dry atmosphere and high temperature are ideal conditions for the development of mites. However, when the mites become established, it bocomes a task of extermination. Fumigation is not in the least satisfactory, as mites, unlike insects, are unaffected by gases, owing to the fact that their breathing apparatus is much more complicated.

Several sprays have been recommended by various writers to kill mites, but all of the sprays known to me at the present writing, only one seems to be practicable and worthy of trial. It consists of one-half pint of "Nico-fume" liquid, such as sold by the Kentucky Tobacco Product Co., Louisville, Ky., and two quarts of lime-sulfur thoroughly mixed in 25 gallons of water. The above has been found entirely satisfactory in killing mites on badly infested sweet clover plants in greenhouses, without injury to the foliage, and I believe it will prove satisfactory when used on other greenhouse plants.

PLANT LICE OR APHIDS

Four species of plant lice found working on greenhouse plants are worthy of mention. One species, commonly known as the melon aphis (*Aphis gossypii*), which varies in color from green to greenish black, is a general feeder (omnivorous) while the others confine their feeding to their respective host plants. These are the green rose aphis (*Nictorophora rosae*), the brown violet aphis (*Rhopalosiphum violae*), and the black chrysanthemum aphis (*Nictorophora chrysanthemicoleus*).

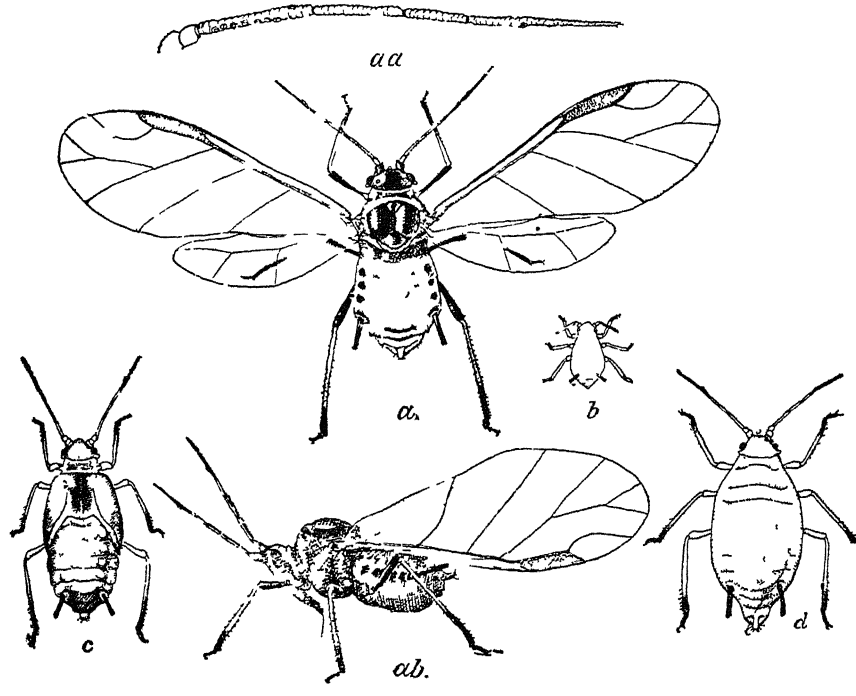


Fig. 7. Melon aphis: a, winged female; aa, enlarged antenna of same; ab, dark female, side view; b, young nymph or larva; c, last stage of nymph; d, wingless female. All greatly enlarged (after Chittenden).

The above insects all belong to the family *Aphididae*, and, unlike most insects, have the habit of giving birth to living young throughout the greater part of the year. Females of two types are developed, both winged and wingless, the former playing an important part in the spread of the species from plant to plant. These insects also have the peculiar habit of reproducing the species parthenogenically (without mating with male). Aphids reproduce very rapidly, it not being uncommon for a single female to give birth

to one or two dozen living young within a short time, and, as the young become mature in a few days and commence giving birth to another generation, one can readily see that if all the offspring from a single female should live, there would be a great number in a few months time. Luckily, no such instance has ever occurred, owing to the fact that aphids have many parasitic enemies and that fair and warm weather conditions do much to suppress them.

At birth, the young aphids immediately commence sucking the juices from their food-plants and, if favorable conditions exist, they may be the cause of severe damage to crops. They have various methods of attacking their host plants; in the case of cucumber they show preference for the underside of the leaf, while with begonias they do not touch the leaves but work on the new shoots and flower buds. Ants are frequently found on plants infested with aphids; the reason for this being that aphids secrete a sweet substance called honey-dew, of which the ants are very fond.

Remedies: Aphids can be easily controlled by fumigation with tobacco. The old method of fumigating with tobacco stems is still employed by many greenhouse men, while others have entirely given up the use of tobacco stems and are using what I consider a very convenient and practical method—fumigating with "Nico-fume" sheets. These sheets are manufactured by the Kentucky Tobacco Product Co., Louisville, Ky. Directions are as follows: Before fumigation, first gather all blooms ready for market. Then close the ventilators, thus making the greenhouse as tight as possible. Preferably have the atmosphere of the house moist. The number of papers to be used at a time will vary according to the tightness of the greenhouse. One should experiment on a small scale at first to determine just how much paper can be used in the house without injury to the plants. According to directions furnished with the prepared sheets, a greenhouse 100x20 feet will require from 8 to 10 sheets under ordinary conditions, and larger or smaller houses in proportion. Papers should be placed or hung up in some convenient way where they can be easily lighted without coming in contact with anything. They may be suspended on a wire between the benches, for example. Light the lower end of the paper and extinguish the blaze at once. It will then continue to burn slowly, giving off pungent fumes. The greenhouse should be fumigated at night and not opened until the following morning; or, on a cloudy day, but never on a bright, sunshiny day. After fumigating, the plants should be thoroughly watered. If the insects are abundant it may be necessary to make from two to three fumigations.

When only a few plants in the greenhouse are infested with aphids, it is hardly practicable to fumigate the entire house. In such case, use "Nico-fume" liquid, or some similar preparation, as a spray at the rate of one to two teaspoonfuls to each gallon of water.

MEALY BUGS (*Pseudococcus citri* and *P. longispinus*)

These are the two most common species found in greenhouses. They belong to the same family as the scale-bugs (*Coccidae*) and breed throughout the year on greenhouse plants. Females are scale-like, wingless, elongate oval, covered with a white, mealy, wax-like powder, and measure, as a rule, from 1-12 to 1-8 of an inch in length. The males are small winged insects, with bluish, iridescent wings. The females are most frequently found closely packed along the depressions on stalks or leaves, or in similar situations, where they are most protected. The two species can be readily distinguished from each other in that *citri* has short, spine-like processes around the entire outer margin, while in *longispinus* these are much longer with several posterior projections, or filaments, commonly measuring as long or longer than the entire insect.

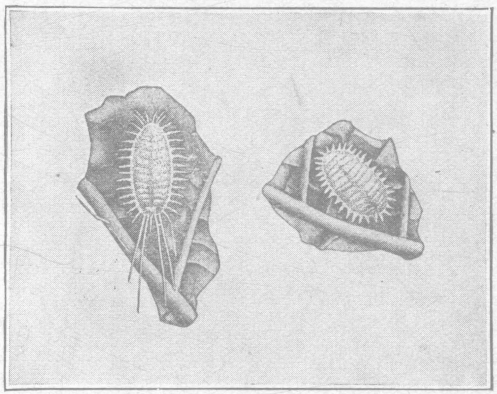


Fig. 8. Mealy bugs. At left Pseudococcus longispinus and on right Pseudococcus citri (after Comstock).

Remedies: Any choice of several methods, if carefully followed, will prove quite satisfactory in controlling mealy bugs. Fumigation with "Nico-fume" paper may be tried. (For directions, see remedies for aphids). Another method consists in spraying with a tobacco-soap solution. First, take some good laundry or insecticide soap and shave off several thin strips into a small quantity of water; boil until entirely dissolved, then mix thoroughly in a gallon of water, and to this add from two to four teaspoonfuls of "Nico-fume" liquid. Stir the solution thoroughly before spraying. Still another method which has been found quite satisfactory, consists in dipping the infested parts of the plant in "Aphine," sold by the Aphine Manufacturing Co., Madison, N. J. Use at the rate of one part of "Aphine" to 20 parts of water. "Aphine" can also be used as a spray in controlling the mealy bug when it is not practicable

to dip the plants, but it is more wasteful in that it is impossible to thoroughly spray plants without losing considerable spray in the air. In all the foregoing treatments it may be necessary to make two or three applications, should the infestation be severe.

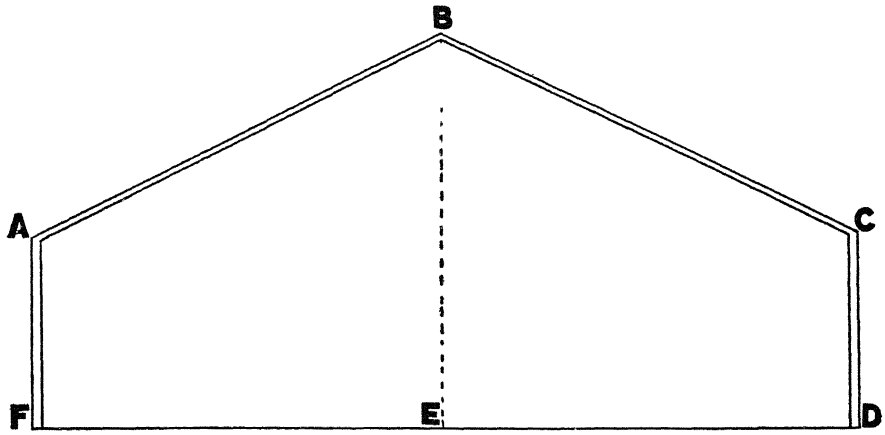


Fig. 9, End view of even span greenhouse. (Original).

HOW TO ESTIMATE CUBIC CONTENTS OF GREENHOUSE

To find the cubic contents of an even-span greenhouse, multiply the area of one end by the length of the greenhouse. For example, find the cubic contents of a greenhouse whose end is represented by letters A B C D E F and whose length is 100 feet. The width F D is 24 feet. Height to ridge pole, represented by line B E, is 12 feet. Height to gutter A F is 6 feet. The area of the end is found by multiplying the width F D, 24 feet, by the average height, obtained by adding B E, 12 feet, and A F, 6 feet, then dividing by 2. The result, 9 feet multiplied by 24 feet, equals 216 square feet. Area of A B C D E F multiplied by the length of greenhouse, 100 feet, gives 21600 cubic feet.

In finding the cubic contents of a three-quarter span house, we have first to divide the end section into four figures, two rectangles and two triangles, then find the area of each figure, add the four of them together and multiply by the length of the greenhouse. For example, let figure A H F G C D represent the end section of such a greenhouse, the length being 100 feet. First measure the height to ridge H C, 12 feet 10 inches. The height F G is 6 feet 6 inches and A D is 5 feet. The distance from D to C is 14 feet 6 inches, and that from C to G, 10 feet 6 inches. To find the area of the retangle A B C D, multiply the base D C, 14 feet 6 inches, by A D, 5 feet. The

result is 72.5 square feet. The area of rectangle E F G C is found in a similar manner by multiplying the base C G, 10 feet 6 inches, by the altitude, F G, 6 feet 6 inches, the result being 68.25 square feet. Having found the areas of the two rectangles, we proceed to find the area of the triangles H F E and A H B. To find the area of a triangle, multiply the altitude by one-half the base. In H F E, one-half the base E F equals 5 feet 3 inches, which, multiplied by the altitude E H, 6 feet 4 inches (the difference between the altitudes F G and H C), gives 33.25 square feet, the area of the triangle. The area of triangle A H B is found in a similar manner by multiplying the altitude H B, 7 feet 10 inches (the difference between the altitudes A D and H C) by one-half A B, 7 feet 3 inches, the result being 56.79+ square feet, the area of triangle A H B. Adding the areas of the figures A B C D (72.5 square feet), E F G C (68.25 square feet), H F E (33.25 square feet) and A H B (56.79+ square feet), we find the total area of the section to be 230.79+ square feet, which multiplied by 100 feet, the length of greenhouse, gives as the cubic contents 23079+ cubic feet.

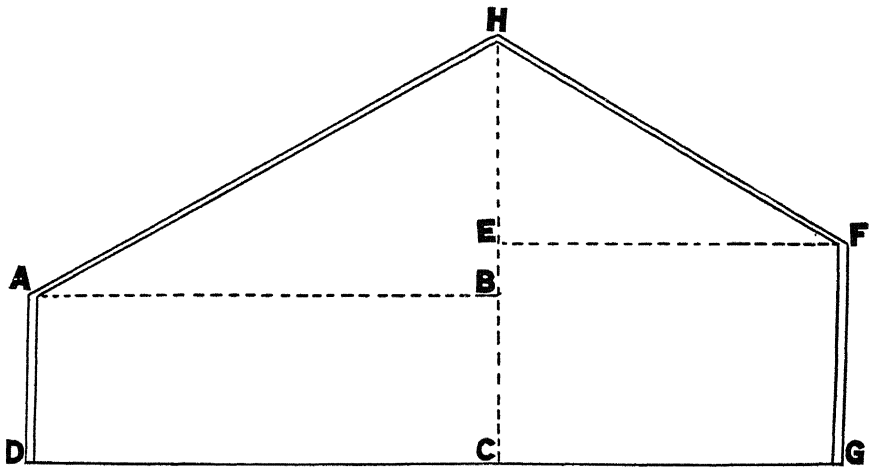


Fig. 10. End view of three-quarter span greenhouse. (Original).

When the different dimensions of a greenhouse are found to be represented by feet and inches, it is sometimes convenient to reduce to inches and, in such case, one must not forget that there are 144 square inches in one square foot, requiring a division by 144 to get the area in square feet.

FUMIGATION DIRECTIONS

Caution: It must be remembered at the outset that potassium cyanide is one of the most deadly of poisons both when taken internally in its crystaline state, and when inhaled in its gaseous condition, consequently, one should use extreme care in the handling of this substance.

First, find the number of cubic feet in the greenhouse to be fumigated.

Second, make the greenhouse as tight as possible by shutting all ventilators and stopping up all cracks.

Third, weigh out in separate receptacle the desired amount of potassium cyanide (98 percent pure) and of commercial sulfuric acid which usually runs about 85 percent pure, and of water, using these ingredients in the following proportions: One ounce of potassium cyanide, two fluid ounces of sulfuric acid, and four fluid ounces of water. See page 96 for amounts.

Fourth, use an earthenware dish or jar to generate the gas, preferably one deep enough to prevent the bubbling liquid from spattering over the edges. If a half-pound of cyanide is used for each charge, the jar used should not hold less than two gallons. It is not best, under ordinary circumstances, to use over one pound of cyanide to a generator.

Fifth, pour the required amount of water into the generator, then slowly add the acid. Now you are ready to add the cyanide, which previously should have been broken into small lumps and placed in thin paper bags. The reason for placing it in the bags is to slightly delay the action of the acid, thus giving the operator time to leave the greenhouse before the fumes are given off. Leave the greenhouse immediately after dropping the bags containing the cyanide into the generators and close the door securely. Under no circumstances should a person enter the greenhouse before one-half hour after opening. If several jars are required in fumigating a large greenhouse, the operator should commence dropping the cyanide in from the far end of the greenhouse and work towards the exit.

Sixth, the jars should be taken out, after thoroughly airing the greenhouse, and the contents either thrown down the sewer or buried in the ground where the refuse can do no damage.

INVESTIGATION OF GREENHOUSE INSECTS

The foregoing circular deals with only a few of the insects troublesome to greenhouse men. It is purposed to issue a more complete treatise at a later time. Greenhouse men are invited to send to the author, reports of damage by all kinds of insect pests troubling them, always accompanying their report with specimens of the damaged plants and of the insects causing the injury.